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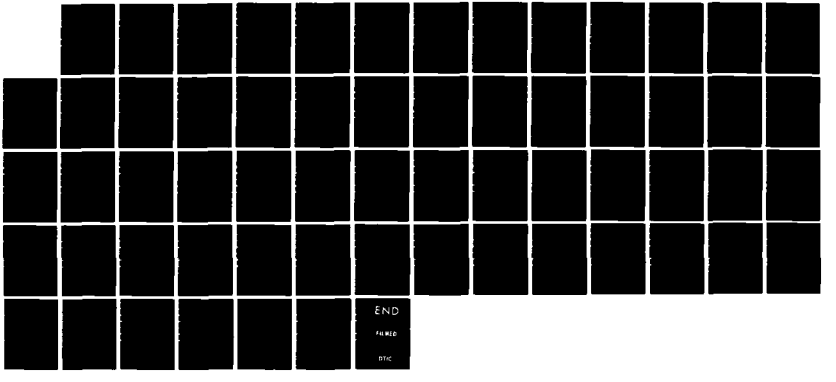

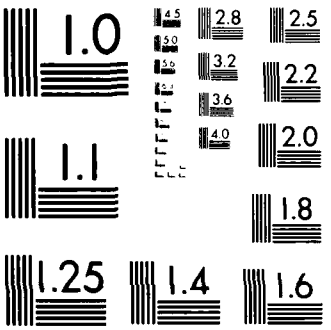

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VALIDATION OF THE ALGORITHM FOR BASE TCTO OVERHEAD COSTS FOR THE COMPONENT SUPPORT COST SYSTEM (D160B)

Contract No. F33600-82-C-0543

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Submitted to:

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EXECUTIVE SUMMARY

Visibility and Management of Operating and Support Costs is a program initiated by the Office of the Secretary of Defense (OSD) in order to ensure that each Military Department gathers, tracks, and computes operating and support costs by weapon system. VAMOSC II is an Air Force management information system which is responsive to the OSD initiative. It uses information from existing Air Force systems to satisfy both Air Force and OSD needs for certain weapon system operating and support (O&S) costs.

At present, the VAMOSC II system comprises three subsystems:

(1) The Weapon System Support Cost (WSSC) system (D160), which deals with aircraft,

(2) The Communications - Electronics (C-E) system (D160A), which deals with ground communications - electronics equipment,

(3) The Component Support Cost Subsystem (CSCS) (D160B), which deals with subsystems and components for aircraft.

The Component Support Cost System (CSCS) of VAMOSC II gathers and computes support costs by assembly/subassembly and relates those costs back to the end item or weapon system. CSCS

replaces the Logistic Support Cost (LSC) model of K051 (AFLCR 400-49) for aircraft and engines.

The CSCS receives inputs from 15 Air Force data systems. On a quarterly basis, the system provides two standard reports each processing cycle and twelve other types of reports as requested by users. It also provides pre-programmed data base extracts on magnetic tape on a one-time basis in response to user requests. Special requests for data in user selected format may also be satisfied on a case by case basis.

At the heart of the CSCS is a set of 30 algorithms for estimation or allocation of costs. Information Spectrum, Inc. (ISI) was awarded a contract to validate these algorithms. This effort included investigations of logic, appropriateness of the algorithms and assumptions inherent in the algorithms. ISI was also to survey published findings, reports of audit, etc. relating to the accuracy to the source data systems. In addition to the algorithm validation, ISI was to perform certain "special tasks," including a user survey.

This report provides the verification of the algorithm called "Base TCTO Overhead Cost." The cost of direct labor performed in maintenance of aircraft is a major component of support costs. This maintenance includes activities in response to Time Compliance Technical Orders (TCTOs), which are "directives issued to provide instructions to Air Force activities for accomplishing one-time changes, modifications, or inspections of equipment or

installation of new equipment." The CSCS algorithm for Base TCTO Overhead Cost calculates and represents TCTO Overhead costs separately from other direct labor costs. These costs are developed for each combination of aircraft MDS and base.

Base maintenance organizations incur costs other than direct labor. These other costs are generally not associated with any particular MDS, and are identified as base maintenance overhead. The CSCS calculates overhead cost per direct labor hour, (including Support General) for each base. This overhead rate (per base) is multiplied times the TCTO manhours to produce the cost of base maintenance overhead associated with TCTO labor expended for each MDS.

The base overhead cost rate discussed in this report is applicable to the development of base maintenance labor, not just TCTO.

In order to verify and validate the CSCS algorithms, a set of analysis procedures applicable to all of the algorithms was established. These procedures were then applied to each algorithm. This report first describes the analysis procedures, without reference to the specific algorithm addressed by this report.

Next, the Base TCTO Overhead Cost algorithm is defined and described in detail. This description includes identification of source data systems and files, and the calculation procedures currently implemented by the CSCS.

Finally, a critique of the algorithm is provided as required by the contract. It addresses the following topics:

- o Verification of assumptions and approximations for appropriateness and accuracy.
- o Validation of accuracy of source data.
- o Validation of appropriateness of source data as inputs to CSCS logic.
- o Investigation of accuracy and appropriateness of algorithms.
- o Consideration of replacement of indirect cost methods with more direct ones.
- o Identification of algorithm impact on CSCS output reports.

For each algorithm addressed, ISI is required to affirm the process or procedure and reject any portion that cannot be affirmed. Where the algorithm or portion of the algorithm is rejected, an alternate procedure must be specified.

The following defects in the Base TCTO Overhead Cost algorithm are noted.

(1) A military labor rate is multiplied by a sum of military and civilian labor hours.

(2) Annual inflation factors are applied once at the beginning of the fiscal year.

(3) Adjustment of labor rates on the basis of inflation factors becomes increasingly inaccurate as time elapses. No explicit provision is made for recognizing or correcting the inaccuracy.

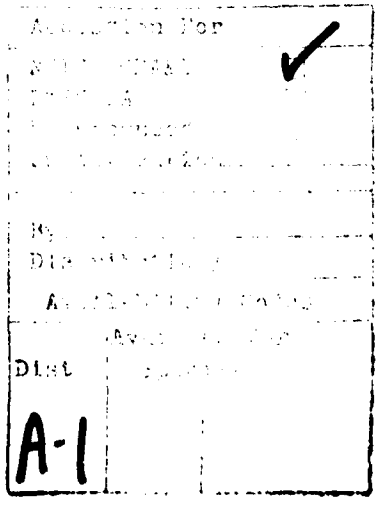
In addition to these flaws, the report notes a problem in accuracy of input data systems. Published reports indicate that manhour data provided by the Maintenance Data Collection System is significantly deficient in both accuracy and timeliness. These deficiencies, if left uncorrected, would tend to negate the usefulness of the algorithm. However, the Air Force is currently testing a new system, the Automated Maintenance System, with considerable promise of correcting the deficiencies.

Three recommendations are provided for correcting the flaws in the algorithm. The first entails providing the CSCS separate manhour data for civilian and military maintenance personnel. This would require changes in coding reports within the Maintenance Data Collection System, in processing these reports by the Product Performance System (DO-56), and in processing these reports by CSCS itself. In addition to providing more accurate labor costs, the recommendation would permit separate display of military and civilian base TCTO labor costs. The recommendation takes on added significance when it is recognized

that it will apply to all base labor cost algorithms, not just TCTO.

An alternative procedure is also offered. The alternative is less accurate and less useful, but simpler to implement. It entails development, through a survey, of composite labor rates for each MDS. The composite rates would reflect an actual mixture of civilian and military manpower.

A simple adjustment procedure is recommended for changing annual inflation rates to values applicable to the quarter. This procedure would be manually implemented.



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1.0 INTRODUCTION

Visibility and Management of Operating and Support Costs is a program initiated by the Office of the Secretary of Defense (OSD) in order to ensure that each Military Department gathers, tracks, and computes operating and support costs by weapon system (all costs are computed and portrayed in "then year" dollars). VAMOSC II is an Air Force management information system which is responsive to the OSD initiative. It uses information from existing Air Force systems to satisfy both Air Force and OSD needs for certain weapon system operating and support (O&S) costs.

At present, the VAMOSC II system comprises three subsystems:

(1) The Weapon System Support Cost (WSSC) system (D160), which deals with aircraft,

(2) The Communications - Electronics (C-E) system (D160A), which deals with ground communications - electronics equipment,

(3) The Component Support Cost Subsystem (CSCS) (D160B), which deals with subsystems and components for aircraft.

1.1 *The Component Support Cost System*

The Component Support Cost System (CSCS) of VAMOSC II gathers and computes support costs by assembly/subassembly and relates those costs back to the end item or weapon system. CSCS replaces the Logistic Support Cost (LSC) model of K051 (AFLCR 400-49) for aircraft and engines.

The objectives of the Component Support Cost System are:

(1) To improve the visibility of aircraft and engine component support costs and to relate those costs to the end item or weapon system.

(2) To improve the Life Cycle Costing capability for the Air Force and the Department of Defense in the acquisition of new weapon systems.

(3) To assist in the design of new weapon systems by providing cost information on existing weapon systems thereby enhancing design tradeoff studies.

(4) To provide historical cost information at the weapon system level to improve logistic policy decisions.

(5) To identify system component reliability, effectiveness, and costs so that high support cost items may be identified and addressed.

The CSCS is described in detail in references [1], [2], and [3]. It receives inputs from 15 Air Force data systems. On a quarterly basis, the system provides two mandatory reports each processing cycle and twelve other types of reports as requested by users. It also provides pre-programmed data base extracts on magnetic tape on a one-time basis in response to user requests. Special requests for data in user selected format may also be satisfied on a case by case basis.

The twelve reports mentioned above are of primary interest to the user community. They are identified by name in Table 1. Descriptions and samples are provided by reference [1].

At the heart of the CSCS is a set of 30 algorithms for estimation or allocation of costs. The algorithms are identified by name in Table 2. Information Spectrum, Inc. (ISI) was awarded a contract to validate these algorithms. This effort includes investigations of logic, appropriateness of the algorithms and assumptions inherent in the algorithms. ISI was also to survey published findings, reports of audit, etc. relating to the accuracy of the source data systems. In addition to the algorithm validation, ISI was to perform certain "special tasks," including a user survey.

1.2 Overview of the Algorithm

This report provides the verification and validation of algorithm 2 of Table 2, "Base TCTO Overhead Costs." Aircraft maintenance includes activities in response to Time Compliance Technical Orders (TCTOs), which are "directives issued to provide instructions to Air Force activities for accomplishing one-time changes, modifications, or inspections of equipment or installation of new equipment," (Reference [12]). The CSCS algorithm for calculations and presentation of Base TCTO Labor Costs has been reviewed by Information Spectrum in reference [17]. Other direct labor cost algorithms will be reviewed in forthcoming reports on Base Inspection Costs, Base Other Support

3.1.3 Description of Calculation Procedure

The following discussion explains the calculation procedure implicit in the calculations of Section 3.1.1 as applied to the inputs defined in Section 3.1.2. The algorithm described in Section 3.1.1., the inputs in Section 3.1.2. and the description of the calculation procedure provided here reflect the actual manner in which the CSCS programs operate. The descriptions of the procedures in the Functional Description and the Users Manual are imprecise, misleading and in some cases incorrect. The programmed procedures form the basis for this analysis. The procedures described by the Functional Description and Users Manual are discussed further in Section 3.2, Critique of the Algorithm.

The first step as shown by the formula in Section 3.1.1(1) is the aggregation of costs attributed to the Chief of Maintenance organization for the base and calendar quarter, identified as BASE-CHIEF-MAINT-COST in Section 3.1.1 and 3.1.2. The cost data are extracted from the USAF Standard Major Command Level Accounting and Budget Distribution System (Data System Designator H069R/XQ). Extracts are furnished to the CSCS on a quarterly basis.

Records providing the quarterly costs for the Chief of Maintenance are extracted from a file named the Base Reported Master File. Extraction is based on codes which define the costs required. The codes are identified in references [3] and [6.25], are provided in Table 4, and will be discussed in Section

TABLE 3. DEFINITION OF SRD PREFIXES

SRD Prefix	Definition
A--	Aircraft and Drones
G--	Support Equipment
H--	Precision Measurement Equipment
N--	Air launched missiles and Guided Weapons
R--	Real Property Installed Equipment, shopwork, ECM Pods, gearboxes, and modules, special purpose pods.
S--	AGE, Gas Turbines, Auxiliary power units.
T--	Trainers, mobile training site & resident training equipment.
X--	Engines

value that is applied to all base direct labor hours.

Source: Reference [7] provides average direct labor rates for FY 80 for each MDS. The military rates of reference [7] are inflated annually by the CSCS by multiplying by the applicable annual inflation index for military manpower cost (referred to FY 80 as a baseline), published annually in AFR 173-13. According to reference [1], rates will be recalculated on an as required basis. No procedure has been established for determining when or how to recalculate the rates. An average of these rates is manually calculated to produce a single direct labor rate for the Air Force.

Name: BASE-LAB-HOURS

Definition: The sum of direct labor hours (including Support General) reported by each base for SRDs beginning with A, G, H, N, R, S, T, and X. See Table 3 for definitions of these codes.

Source System/File: D056A/MNI75A0

Name: TCTO-MDS-BASE-MH-ON

Definition: On-Equipment TCTO manhours reported for the MDS, base and calendar quarter. Includes TCTO performed on the engine.

Source System/File: D056A/MNI75A0

Name: TCTO-MDS-BASE-MH-OFF

Definition: Off-equipment TCTO manhours reported for the MDS, base and calendar quarter. Includes TCTO performed on the engine.

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references [1], [2], and [3], and on direct discussion with personnel of the Office of VAMOSC. In case of any discrepancies, information provided by knowledgeable personnel was accepted as most current, hence most definitive.

3.1.1 Calculations

For purposes of this analysis, it is convenient to express the calculations performed by the CSCS by three formulas:

(1) BASE-MAINT-OVHD-COST =

BASE-CHIEF-MAINT-COST - DLR x (ΣBASE-LAB-HRS)*

*Includes all direct labor hours (plus Support General) reported by the base for SRDs beginning with A, G, H, N, R, S, T, and X. These SRDs define that subset of SRDs that are connected with aircraft operations and maintenance and not just aircraft and engine SRDs.

(2) $$\text{BASE-MAINT-OVHD-COST-RATE} = \frac{\text{BASE-MAINT-OVHD-COST}}{(\Sigma\text{BASE-LAB-HRS})^{*}}$$

*Includes all direct labor hours (plus Support General) reported by the base for SRDs beginning with A, G, H, N, R, S, T and X. These SRDs define that subset of SRDs that are connected with aircraft operations and maintenance and not just aircraft and engine SRDs.

(3) MDS-BASE-TCTO-OVHD-COST = BASE-MAINT-OVHD-COST-RATE

x (TCTO-MDS-BASE-MH-ON + TCTO-MDS-BASE-MH-OFF)

3.1.2 Inputs

Name: BASE-CHIEF-MAINT-COST

Definition: Total cost of the Chief of Maintenance Organization for the base and for the calendar quarter determined from the base financial system.

Source System/File: H069R/FXQAXFNAUXX

Name: DLR

Definition: Average worldwide direct military labor rate for maintenance for at base level. This is a single

3.0 ALGORITHM ANALYSIS

The previous section described the general analysis procedures applied to all algorithms. This section presents the results of applying those procedures to the algorithm for Base TCTO Overhead Costs.

Section 3.1 provides a detailed description of the algorithm and of the input data it uses. Section 3.2 provides a critique, structured to correspond to the contractual requirements. Section 4.0 makes recommendations for solutions of problems.

3.1 Algorithm Description

In the following description COBOL-type data names are used to express the algorithm output and its components. The available source documentation does not provide the actual data names used by the CSCS programs. They are presumably different from those used in this report.

This description provides a formula for the calculation that is derived from the Users Manual and other sources. It is not the same as the formula provided in the Users Manual. It is intended to be more explicit. The formula is stated in Section 3.1.1. The input data elements and their sources are provided in Section 3.1.2. The calculation is described verbally in Section 3.1.3. Unless otherwise noted, the descriptions are based on

2.4 Problem Resolution

Whenever a significant deficiency was recognized in one of the algorithms, one or more proposed solutions were developed. This was a creative analytic process for which few guidelines could be proposed in advance. Certainly it depended on familiarity with the various existing Air Force data reporting and processing systems. Proposed solutions were discussed with personnel of the Office of VAMOSC, and revised as appropriate. Recommended solutions were expressed in the form of contributions to a draft Data Automation Requirement (DAR) when these would be applicable.

2.5 Documentation

The documentation of the analysis of each algorithm was a crucial part of the effort. Emphasis was placed on making it thorough, clear, and unambiguous. In the documentation, every assertion was substantiated. This was done by reference to source documentation, by explicitly expressed application of the experience and judgment of the contractor, or by citation of information provided by cognizant Air Force personnel. In the last case, the information was supported by documentation identifying the source, the date, and the information provided.

algorithm for base maintenance overhead costs, assume that for a single reporting period all maintenance labor is overhead and none is direct. Also try the reverse assumption. If an assumption of an extreme input leads to an illogical result, the algorithm is flawed.

General Task (4) of Section C-2 of the contract speaks of appropriate statistical techniques to confirm or repudiate each algorithm. Statistical techniques could confirm or repudiate only statistical hypotheses as assumptions. (Use of an average does not constitute an assumption.) Accordingly, statistical techniques apply to confirmation or repudiation of an algorithm only to the extent that statistical hypotheses can be developed.

(f) As each algorithm is considered, ensure that the costs do not overlap others already accounted for. (In some cases an overlap may be necessary and desirable. where this occurs, the overlap will be noted.)

(g) In each CSCS output report, identify the data elements incorporating the output of the algorithm, so that a final assessment of report accuracy can be made for each output report.

(h) Consider alternative sources of input data for the algorithm. Also consider more direct cost assignments than those incorporated in the algorithm.

translate mathematical formulas and data processing techniques into meaningful concepts.

Some explicit techniques which were generally used in concept validation are listed below.

(a) Consider how the cost element would be calculated if there were no constraints on resources. (For example, suppose the CSCS could identify the pay grade and hours worked of each individual involved in a maintenance action.)

(b) Identify assumptions* incorporated into the Algorithm. Generally this procedure will identify the real constraints which affect the approach in (a) above.

(c) Identify approximations incorporated into the algorithm. For instance, one such approximation is the use of an average labor rate for each aircraft.

(d) Study each approximation for possible sources of error. Some examples are biases introduced by editing procedures, obsolete data, or inappropriate application. Whenever feasible, estimate the likelihood of these errors by reviews of the literature and contact with cognizant personnel.

(e) Test the algorithms under conditions of assumed extreme values for the inputs. For instance, in evaluating the

* Note that assumptions, approximations, and allocations are different concepts, although in some cases the boundaries between them are not sharp. ISI has recognized few assumptions in the algorithms, but many approximations and allocations.

2.2 Input Data Definitions

Closely related to the first step was the clarification of the definitions of the input data. The identification of each input data element and of the system providing it was provided by the User's Manual (reference [1]). This identification was refined by identification of a particular file within the source system and the structure of the file as described in both the CSCS System/Subsystem Specification and in the Memoranda of Agreement. The Memoranda of Agreement have been established between the Office of VAMOSC and the Offices of Primary Responsibility (OPR) for the systems providing the input data. Any inconsistencies or voids were identified and resolved through contact with the Office of VAMOSC and/or implementing personnel.

Whenever appropriate, input data element definitions were further refined by tracing the elements back to their sources through the reference data provided. If these were inadequate, the OPRs were contacted directly for clarifications. In tracing the data back to their origins, possible sources of data contamination were considered. Information on the likelihood and significance of such contamination was collected from cognizant personnel and from published references.

2.3 Concept Validation

The two steps above established exactly what the algorithm does. The third, and most critical step, considered the validity of the procedure. It depended on the ability of the analyst to

2.0 ANALYSIS PROCEDURES

In order to verify and validate the CSCS algorithms, a set of analysis procedures applicable to all of the algorithms was established. These procedures were then applied to each algorithm. This section describes the analysis procedures, without reference to the specific algorithm addressed by this report.

The algorithm analysis process consists of five portions, described in the following sections.

2.1 Algorithm Description

The algorithms are described in references [1], [2], and [3]. These descriptions are not identical. In general they supplement, rather than contradict each other. The first two describe what the system is to achieve; the third describes the system design to do so.

None of these descriptions provides the combination of level of detail and clarity of concept required for this validation effort. The first step in the analysis methodology was the generation of such a description. The descriptions in the three reference sources just cited were made explicit. When necessary, Air Force personnel involved in implementation of the D160B subsystem were contacted for clarification.

overhead costs for each direct labor category for each MDS by multiplying the overhead rate times the direct labor hours for that category. Thus the rate applies to each algorithm which produces any direct labor hours.

General Costs, and Base Labor Costs. These categories cover all base maintenance direct labor costs reported for aircraft. However, there are other base indirect costs associated with these labor hours, as will be seen.

In order to develop Base TCTO Overhead Costs, the CSCS identifies the total costs of the Chief of Maintenance organization at each base. This is derived from the base Accounting and Budget Distribution System (HO69R). The total of all direct maintenance labor costs for all MDS at the base are subtracted from the total cost of the Chief of Maintenance organization at that base. The total direct maintenance labor costs are computed by multiplying an overall CSCS Direct Labor Rate by the direct labor hours reported to the Maintenance Data Collection System (MDCS) for all aircraft MDSs and support equipment (Specific Standard Report Designations are identified in Table 4 which is provided at paragraph 3.1.3) The residue cost determined by subtracting the direct labor costs from the total cost of the Chief of Maintenance Organization is identified as base maintenance overhead costs.

This residue cost is divided by the total of direct maintenance manhours for the base to yield a maintenance manpower overhead rate for that particular base. In the case of this algorithm, the overhead rate is multiplied times TCTO manhours for each MDS at the base to produce the overhead cost associated with those TCTO labor hours. Note that the overhead rate for each base established in this algorithm is used to develop

TABLE 2. CSCS ALGORITHM NAMES

1. Base TCTO Labor Cost
2. Base TCTO Overhead Cost
3. Base TCTO Material Cost
4. TCTO Transportation Costs
5. Base Inspection Costs
6. Base Other Support General Costs
7. Base Labor Costs
8. Base Direct Material Costs
9. Base Maintenance Overhead Costs
10. Second Destination Transportation Costs
11. Second Destination Transportation Costs (Engine)
12. Base Exchangeable Repair Costs (NSN)
13. Base Exchangeable Repair Costs (Engine)
14. Base Exchangeable Modification Costs (NSN)
15. Base Condemnation Spares Costs/NSN
16. Base Exchangeable Modification Costs (Engine)
17. Base Supply Management Overhead Costs
18. Depot TCTO Labor Costs
19. Depot TCTO Material Costs
20. Depot TCTO Other Costs
21. Depot Support General Costs
22. Depot Labor Costs
23. Depot Direct Material Costs
24. Depot Other Costs
25. Depot Exchangeable Repair Costs (NSN)
26. Depot Exchangeable Repair Costs (Engine)
27. Depot Exchangeable Modification Costs (NSN)
28. Depot Exchangeable Modification Costs (Engine)
29. Depot Condemnation Spares Costs (NSN)
30. Depot Material Management Overhead Cost

TABLE 1. CSCS OUTPUT REPORTS

Number*	Name
8105	Cost Factors
8104	MDS Logistics Support Costs
8106	Base Work Unit Code (WUC) Costs
8107	Total Base Work Unit Code (WUC) Costs
8111	Depot On-Equipment Work Unit Code (WUC) Costs
8108	Total Base and Depot Work Unit Code (WUC) Costs
8109	NSN-MDS-WUC Cross-Reference
8110	MDS-WUC-NSN Cross-Reference
8112	Logistic Support Cost Ranking, Selected Items
8113	Summary of Cost Elements
8114	NSN-WUC Logistics Support Costs
8115	Assembly-Subassembly WUC Costs

*CSCS output reports are assigned Report Control symbol HAF-LEY(AR)nnnn, where nnnn is the number in the table.

Table 4. H069R DATA EXTRACTION CRITERIA

Data Element	Selected Values
Fund Code (FC)	29, 30, 9A, 54, 55, 68
Responsibility Center/ Cost Center (RC/CC)	XX20, XX21, XX22, XX23, XX24 XX25, XX2G, XX2E, XX2R
Element of Expense Investment Code (EEIC)	2XX, 391, 392, 393, 396, 40X, 47X, 48X, 49X, 5XX, (except 58X, 59X, and 570), 619, 63X, 641, and 693
Balance ID	U or E

3.2.3.1. Data extractions defined by the codes in Table 3 comprise all costs covered by the maintenance organization for aircraft at each base.

Next, the total of all direct maintenance labor hours reported by the Chief of Maintenance organization at a base is accumulated. These data are obtained from the MDCS and include all direct labor hours for all systems worked on by the Chief of Maintenance organization that are in any way connected with aircraft operations. These systems are defined by all System Reporting Designators (SRDs) beginning with A,G,H,N,R,S,T,&X. The systems defined by these SRDS are described in Table 3.

These direct labor hours are then multiplied by a direct labor rate that is the average of worldwide military labor rates for all MDS. The military direct labor rates for each MDS were determined by AFAFC/XSMC based on FY 80 data and provided to AFLC/MM (VAMOSC) for use in CSCS. These rates are escalated to the appropriate fiscal year prior to averaging by AFLC/MM (VAMOSC). The average worldwide military labor rate thus developed is a single average value that is uniformly applied to the direct labor hours accumulated quarterly for each base. The average direct labor rates must be computed because the direct labor hours that are accumulated at each base represent a wide range of systems. The only direct labor rates currently available are those that are unique to each MDS. Since all the direct labor worldwide is performed by the Chief of Maintenance organizations, an average of these costs is applied uniformly to

the direct labor hours performed on each base.

The value thus determined for each base is subtracted from the total cost of operation of the Chief of Maintenance. The remainder defines the total base maintenance overhead cost as shown by the algorithm in Section 3.1.1.(1).

The algorithm in Section 3.1.1(2) develops a base Overhead Cost Rate. It divides the total base overhead cost produced in the algorithm in Section 3.1.1(1) by the sum of all direct labor hours for the base, also developed in Section 3.1.1(1). This distributes the overhead cost equally to all direct labor hours accumulated for the aircraft associated SRDs reported by that base. The overhead cost rate may then be applied to any of the direct labor hours (including Support General) for aircraft associated SRDs without double accounting the base overhead cost. Conversely, application of the overhead cost rate only to those aircraft direct labor hours involved in CSCS algorithms does not recoup all of the base overhead costs. For the purposes of this algorithm the overhead cost rate for each base is multiplied by the TCTO direct labor hours for each MDS to produce the TCTO overhead cost for the MDS/base. Note that neither direct labor cost nor overhead costs associated with maintenance of non-airborne equipment are reported by the CSCS, nor are they intended to be reported.

3.2 Critique of Algorithm

This section addresses various facets of the algorithm. The discussion is structured to correspond to the contractual require-

ments. Each aspect is either affirmed or rejected. Rejections lead to recommendations in Section 4.0.

As addressed earlier, the algorithm as expressed in Section 3.1.3 forms the basis of this critique. The algorithm as described in the User Manual, AFR 400-31, Volume IV, paragraph 5-4 is improperly stated since it is not programmed in the manner described. Paragraph 3.2.1 d. of the Functional Description, Reference [2], is likewise improperly stated.

3.2.1 Appropriateness and Accuracy of Assumptions and Approximations.

Information Spectrum has identified two assumptions or approximations (either term is appropriate) implicit in the algorithm. The first is that average worldwide labor rate used to compute the cost of aircraft related direct labor in 1980 is the same as the average for all aircraft-related maintenance in 1980. The second is that the rate of inflation for this labor rate is the same as the rate applicable to military manpower cost in general.

Addressing the first assumption, every category of direct labor that is identifiable through the MDCS at the base level is involved in this algorithm. Therefore, the average worldwide labor rates are appropriate to this algorithm. Any skewing effects are mitigated by the mix of labor involved. This argument, admittedly very indirect, suggests that the direct labor rate applied to determine base direct labor costs should lie near the average, and therefore application of the average labor rate

for all maintenance is reasonable in this algorithm. ISI can see no feasible approach to a more direct verification of this assumption.

The second assumption concerns whether inflation factors for this labor rate might differ significantly from those for all military personnel. ISI analysts have tracked various inflation indices for many years. Our experience indicates that differences between indices for similar quantities are invariably negligible.

Accordingly, ISI affirms the appropriateness and accuracy of assumptions and approximations incorporated in this algorithm.

3.2.2 Accuracy of Source Data and Congruence of Data Element Definitions

Information Spectrum was directed to validate accuracy of source data based on a survey of published findings, reports of audit, etc. No direct sampling of data was to be performed. The Office of VAMOSC has indicated that direct validation of source data is planned for future efforts.

The source data consists of total cost for the base maintenance organization provided by the USAF Standard Base Level Accounting and Budget Distribution System (H069), manhours provided by the Product Performance System (D056), an average worldwide labor rate produced from the average of worldwide MDS military labor rates for FY 80 provided on a one-time basis, and inflation factors published annually by the Air Force. The accuracy of the source data and the congruence of the definitions

of the data element are discussed for each of these separately in the subsections below.

3.2.2.1 Cost Data

No published criticisms of the accuracy of financial data in the H069 system were found. The system is a basic accounting system for the Air Force. Accordingly, ISI accepts the cost data as accurate.

The next question is whether the definition of total maintenance organization costs as used in the CSCS is congruent with the definition implicit in the input data system. The available documentation does not provide any explicit definition of total maintenance organization costs other than that implicit in the Memorandum of Agreement requesting the data from system H069. Thus the question of congruence does not apply.

3.2.2.2 Manhours Data

Manhours data used in this algorithm has the same characteristics as manhours data used in the TCTO Labor Cost algorithm. Accordingly, the following discussion is the same as the one in reference [17].

Published reports such as references [10] and [11] indicate that manhours data provided by D056 are quite inaccurate. the data in D056 are sent to it by each base, through a system known as the Maintenance Data Collection System (MDCS). The MDCS, in turn, gets its data from forms filled out manually by maintenance personnel. MDCS data have been assailed as plagued by inaccuracy

and lack of timeliness. Reference [11], known in Air Force VAMOSC circles simply as the "the GAO report," provides indictment of the MDCS data and suggests that systems based on it will not be believed or much used by the maintenance community. The GAO report often relies on small samples, and it is more ancedotal than scientific. Nevertheless, as a whole it is convincing.

One study whose results are incorporated (though not explicitly identified) in the GAO report, is provided by reference [10]. This study, conducted in the fall of 1978, was concerned with the accuracy of base maintenance manhours reported by the MDCS. The study was restricted to two Tactical Air Command bases, and a total of 119 maintenance events, selected to be of short duration. Although this sample cannot be freely extrapolated to all maintenance events in the Air Force, there is no doubt about the significance of two of the findings.

First, of the maintenance events observed, only about half could later be identified among the reports in the Maintenance Data Collection (MDC) system, despite determined efforts. Note that this was an unexpected result for which the study had not been designed. The report does not give the explicit criteria which were used to identify a match. The second significant result was that for the maintenance events which could be identified, the manhours reported to the MDC system averaged about twice as much as the quantities recorded by the study personnel.

The Air Force is testing an automated system which holds promise of considerably improving the accuracy of reporting of

maintenance manhours. This system, called the Automated Maintenance System (AMS), provides for real time, automated input, editing, and retrieval of data of the MDCS. The AMS is currently being tested at Dover AFB. The GAO report does not provide direct evidence of improved accuracy provided by the AMS, but it cites impressive improvements in the number of maintenance actions reported as completed. It also indicates that Air Force officials believe that the AMS virtually eliminates inaccuracy in MDC data. The Air Force is currently implementing a Core Automated Maintenance System (CAMS) which will be a standard base level system with all of the desireable features of the AMS.

On the basis of the published reports, ISI concluded that manhours data provided by the D056 system is at present generally subject to significant errors, with direct adverse impact on the accuracy of the output of the algorithm.

There is congruence between the definitions of maintenance manhours as provided by the input data system and as used by the Base TCTO Overhead Cost algorithm.

3.2.2.3. Labor Rates

Labor rates are used in this algorithm the same way they were used in the TCTO Labor Cost algorithm (reference [17]. Accordingly, the following discussion is the same as in that reference. Reference [17] indicates that military labor rates for FY80 were calculated for each MDS using the same procedure as normally used by the Maintenance Cost System for individual maintenance organizations. This procedure uses standard pay rates

for each pay grade from reference [13]. These rates are a composite of all pay, allowances, and entitlements. The rates are weighted by direct labor hours reported to yield an average direct labor rate. Because of this weighting, it might appear that this average would be significantly distorted by the inaccuracies in manhour reporting just discussed. ISI does not believe that this is the case, for the following reasons. It is evident from discussion with Air Force Personnel, and confirmed by review of an example in reference [14], that manhour reporting includes 8 hours for every work day. The weighted average would be distorted if lower rate personnel were inflating reports of direct labor significantly more than higher rated personnel, or vice versa. We do not find this credible. ISI believes the military labor rates used in the algorithm to be accurate.

The congruence of definitions of labor rates used in the algorithm with the definitions appropriate to the input systems is another matter. The algorithm applies the labor rates to manhours which are the sum of military and civilian manhours. The labor rate used, however, is the military rate. This lack of congruence distorts the output of the algorithm.

3.2.2.4 Inflation Factors

The final inputs are the inflation factors for military pay. Information Spectrum sees no problem with the accuracy of these, and affirms their accuracy. There is, however, another problem in congruence of definition. The inflation factors provided by reference [15] apply to the midpoint of the year. The CSCS

reports are quarterly, and it would be appropriate to use inflation factors scaled to the quarter. The current procedure will apply four quarters' worth of inflation between the quarter at the end of one Fiscal year and the quarter at the beginning of the next. A user comparing cost data for these two quarters may be led astray. With recent inflation rates well in excess of 10%, this effect could be significant. ISI considers the lack of congruence between the definitions of inflation rate as provided by the input system and as used by the CSCS unacceptable.

3.2.3 Appropriateness of Source Data as Inputs

As in Section 3.2.2, the three kinds of source data are addressed separately in the following subsections. The discussions in Subsections 3.2.3.2 and 3.2.3.3 are essentially identical with the ones which appeared in reference [17].

3.2.3.1 Cost Data

Review of various documents, notably references [19] and [20], indicates that base accounting and finance information is available through just two data systems, H069 and H069R. The H069 system provides automated accounting and finance functions at each separate base. The data is consolidated through the H069R system. It is implicit in the explanations, especially in reference [19], that the H069R system provides the single consolidated source for descriptions of all base level expenses (among other financial data). As such, it is the appropriate source for total maintenance organization costs.

With H069R, all base expense reports are accumulated in a file identified in Chapter 14 of reference [19] as the Base Reported Update File (File Number WXQAAFODU). Records are selected from this file on the basis of extract codes which were identified in Table 4 to provide base maintenance organization costs.

The records contain 23 fields. ISI reviewed the definitions of each record (reference [18]), and concurs that the ones selected as criteria in Table 4 are appropriate. Next, ISI reviewed the values selected for each code (again reference [18]), and those not selected, as well as those omitted, and the meaning of each. "Balance IDs" U and E include expenses accrued but unpaid and disbursements. Other Balance IDs were authorizations, management values, etc. Accordingly, the restriction to values U and E is appropriate. Similarly, the RC/CC codes properly restrict attention to all possible costs for base maintenance organizations.

The fund codes (six out of dozens of possible values) include operations and maintenance (O&M) for the Regular Air Force, the Reserves, and the Air National Guard. The cost of military personnel at standard rates is a separate code, leading to uncertainty over what costs are covered by the O&M codes. Also military personnel costs (not specified "at standard rates") are not included. Two other codes included cover RDT&E and Airlift Service, AFIF. The meanings of these, when combined when maintenance RC/CC codes, is not evident.

The Element of Expense/Investment Codes (EEIC) are chosen from a list of hundreds. In addition to the costs of military and civilian personnel, these include a variety of costs of utilities (e.g., electric power), communications (e.g., telephone), and fuel for ground vehicles (but not for heat or power). Also included are a wide variety of miscellaneous costs (the 5XX series) covering such areas as printing, snow removal, landscaping, etc. The selected EEICs represent appropriate O&S costs for a weapon system.

The appropriateness of the criteria becomes a more complex question when their concurrent impact is considered. The appropriateness of the RC/CC and Balance ID codes is unquestionable. The appropriateness of the data selected by the EEIC and Fund codes is also affirmed. It appears that costs ruled out by these extract codes would, in fact, never be reported for a maintenance organization or be appropriate to major weapon system maintenance costs. Thus, although the total set of extract codes may be unnecessarily complex, it is ISI's judgment that the complexity has no undesirable effect. Accordingly, we affirm the selected H069 data as appropriate for maintenance organization costs.

3.2.3.2 Manhours Data

The need for manhours data as inputs to this algorithm is self-evident. The D056 data accurately reflects the data logged by maintenance personnel. No other source of maintenance manhours data exists. Accordingly, ISI affirms the use of the

D056 data as a source of manhours. It must be recognized, however, that improvement in source data accuracy is highly desirable, as discussed in Section 3.2.2.

3.2.3.3 Labor Rates

The appropriateness of the average labor rates as adjusted by inflation is adequate at present, but it will deteriorate as time goes by. The labor rates represent a mix of pay grades valid in 1980. This mix will lose validity as Air Force manpower responds to the national socio-economic environment, and as aircraft are subjected to aging and modification. The assertion of reference [1] that the labor rates will be recalculated "on an as required bases" is not supported by a methodology. Accordingly, ISI finds this input inappropriate.

3.2.4 Accuracy and Appropriateness of Algorithm

The algorithm is based on the concept that all costs generated by the base maintenance organization other than the cost of direct labor should be identified as maintenance overhead. For CSCS purposes, these overhead costs are distributed to the total direct labor hours (all categories) generated at a base. The overhead cost per direct labor hour is then applied to each class of direct labor activity (TCTO in this case) for each MDS. Given the CSCS objective of associating support costs with end items or weapon systems, these concepts appear appropriate.

In the detailed implementation, some delicate points arise.

First, although the cost of maintenance manpower at each base is available from H069R, the cost of direct labor is not reported by this system. Direct manhours are reported by the MDCS but the pay grades are not available to produce the cost. Accordingly the CSCS uses worldwide average labor rates for each MDS.

The direct labor costs for aircraft are developed by the CSCS, and are separated into categories as discussed below. There is a natural way to allocate base maintenance overhead costs to these categories. The base maintenance overhead cost developed by the CSCS, which is illustrated by Figure 1, operates as follows. At each base the direct labor hours used for each SRD beginning with A, G, H, N, R, S, T and X are collected (See Table 3). For each SRD, these hours are categorized as on-equipment maintenance, off-equipment maintenance, inspection, support general (other than inspection), or TCTO. These categories are non-overlapping, and account for all direct maintenance labor that is reported for aircraft. Then, as indicated in Figure 1 by the dashed lines in the box labeled "overhead costs," the total base maintenance overhead costs are allocated among equipments identified by the SRDs and the maintenance categories in the same proportions as the direct labor hours.

These proportions can be maintained by dividing the base maintenance overhead cost by the total of all direct labor hours, represented by the block labeled "Direct Labor Hours" in Figure 1. Then the allocation of overhead costs to one category, e.g., TCTO for MDS 1, is achieved by multiplying the resulting overhead

Attachment 1: Proposed change to CSCS Users Manual, AFR 400-31, Volume IV, page 64, paragraph 5-4.

5-4 Base TCTO Overhead Cost. This cost element is calculated by multiplying Base TCTO Man-Hours by an overhead cost rate developed for each base. The overhead cost rate for each base is developed in such a way that it can be applied to any direct labor hours reported to the MDCS by that base. In this case, the Base Overhead Cost Rate per base direct labor hour is applied to the TCTO manhours per MDS per Base to generate the Base TCTO Overhead Cost. The Base Overhead Cost Rate can be, and is, applied to other direct labor hours. An example of this is shown in the algorithm for Base Maintenance Overhead Costs in paragraph 5-11.

a. TCTO MH/MDS Base. The total of the three types of TCTO manhours by MDS for each Base listed below is multiplied by the overhead cost rate for that Base.

Data System	Data Element
(1) D056A	TCTO MH/MDS/BASE, on-equipment
(2) D056A	TCTO MH/MDS/BASE, engine
(3) D056C	TCO MH/MDS/BASE, off-equipment

b. Overhead Cost Rate/Base. The overhead cost rate per direct labor hour for each base is generated by subtracting the cost of direct labor for all aircraft-related SRDs at each base from the total cost of the Chief of Maintenance organization at each base. The remainder is defined as the base maintenance overhead cost. This overhead cost is divided by the same direct labor hours used

MEMORANDA OF AGREEMENT
FOR SYSTEM INTERFACES (Continued)

Ref. No.	Memorandum No.	Date
[6.24]	H036B/RC/D160B-A	10 Feb 1981
[6.25]	H069R/M024B/D160B-B	19 Jan 1981
[6.26]	O013/BDN/D160B	22 Jul 1982

MEMORANDA OF AGREEMENT
FOR SYSTEM INTERFACES

Ref. No.	Memorandum No.	Date
[6.1]	D002A/M024B/D160B-A	9 Jun 1980
[6.2]	D002A/M024B/D160B-B	9 Jun 1980
[6.3]	D024A/D160B-A	30 Jun 1980
[6.4]	D033./ARC/D160B	14 Jun 1980
[6.5]	D042A/DNB/D160B	4 Nov 1983
[6.6]	D046/M024/D160B	9 Apr 1981
[6.7]	D046/D160B	23 Jun 1982
[6.8]	D056A/BDN/D160B-A	23 Jan 1981
[6.9]	D056A/D160B-C	13 Oct 1981
[6.10]	D056A/D160B-D	29 Jan 1981
[6.11]	D056A F005	25 Apr 1979
[6.12]	D056B/BDN/D160B-A	22 Dec 1980
[6.13]	D056C/D160B-A	4 Mar 1981
[6.14]	D071/D160B	17 Jun 1982
[6.15]	D143B/D002A 9159	3 Aug 1979
[6.16]	D143F/ARC/D160B-A	5 Feb 1981
[6.17]	D160/D160B	11 Jun 1982
[6.18]	G004L/M024B/D160B-A	30 May 1980
[6.19]	G004L/M024B/D160B-B	30 May 1980
[6.20]	G004L/M024B/D160B-C	5 Nov 1981
[6.21]	G019F/D160B	8 Sep 1982
[6.22]	G033B/D160B	12 Jul 1982
[6.23]	G072D/BDN/D160B-A	19 Apr 1982

[42] VAMOSC Operating Instruction 7, Component Support System (CSCS), Mission Support of the CSCS (D160B), 9 April 1982

[43] VAMOSC OI7, 28 December 1983

[44] AFLC Regulation 75-1, Shipment Processing and Documentation, 15 October 1975, updated to 21 December 1977

[45] AFM 400-1, Volume I, Selective Management of Propulsion Units, Policy and Guidance, 21 June 1976

[46] Aircraft Operating and Support Cost Development Guide, Office of the Secretary of Defense, Cost Analysis Improvement Group, 15 April 1980

[47] Letter from ACM to ALMAJCOM-SOA/ACM/ACC/ACR, Subject: Commercial/Industrial Type Activities (CITA) Factor Development Procedures (RCS: HAF-ACM(AR)8004) (AF/MPMX Msg, 251445Z Jul 80), signed by Donald G. Kane, Colonel, USAF, Director of Cost and Management Analysis

[48] AFLC Regulation 65-12, Management of Items Subject to Repair (MISTR). 2 August 1978

[49] AFLC Regulation 66-61, Operational Planning, 27 October 1983

[50] "Validation of the Algorithms for Depot Support General, Labor, Direct Material, and Other Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-15, 12 April 1984

[51] AF Manual 177-206, Automated Material System Interfaced with Supply System at Base Level, Users Manual, 1 August 1979, updated to 1 February 1983.

[52] AF Regulation 66-1, Maintenance Management, Volume 3, Squadron Maintenance, 2 January 1980

[53] "Validation of the Algorithm for Base Inspection Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-04, 15 August 1983

[29] DoD Handbook 7220.29-H, Department of Defense Depot Maintenance and Maintenance Support Cost Accounting and Production Handbook, updated through 13 September 1979

[30] AF Manual 400-1, Volume II, Comprehensive Engine Management System (D042) Engine Status, Configuration and TCTO Reporting Procedures, 1 October 1983

[31] "Validation of the Algorithms for Base Exchangeable Repair Costs (Engine) and Base Exchangeable Modification Costs (Engine) for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-10, 11 February 1984

[32] TO-00-5-15, Technical Manual: Air Force Time Compliance Technical Order System, 15 April 1983

[33] "Validation of the Algorithm for Depot TCTO Labor Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-12, 12 April 1984

[34] "Validation of the Algorithm for Depot TCTO Material Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-13, 12 April 1984

[35] "Validation of the Algorithm for Depot TCTO Other Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-14, 12 April 1984

[36] AFLC Regulation 170-10, "Depot Maintenance Service Air Force Industrial Fund (DMS, AFIF) Financial Procedures, 28 June 1979, updated to 16 February 1982

[37] "Validation of the Algorithms for Base Exchangeable Repair Costs (NSN) and Base Exchangeable Modification Costs (NSN) for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-84-31859-09, 11 February 1984

[38] AF Manual 67-1, "USAF Supply Manual," Vol. II (Ph IV) Part II, 1 February 1984

[39] "Validation of the Algorithm for Base Maintenance Overhead Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-08, 13 December 1983

[40] "Aircraft Operating and Support Cost Development Guide," Office of the Secretary of Defense, Cost Analysis Improvement Group, 15 April 1980

[41] DoD 7220.29H, "DoD Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting Handbook," updated through 28 October 1981

[16] HQ USAF/ACF (AFAFC) Denver, Co ltr (undated), Subject: Direct Labor Rates for VAMOSC (your 21 Apr 83 ltr)

[17] "Validation of the Algorithm for Base TCTO Labor Cost for the Component Support System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-01, 15 August 1983

[18] AF Regulation 300-4, Vol. III, Unclassified Data Elements and Codes, 1 May 1982

[19] AF Manual 177-674, USAF Standard Base Level Accounting and Distribution System (AFDS): H069R/XQ (H6000), 1 April 1982, updated to 18 June 1982

[20] AF Manual 177-370, USAF Standard Base-Level Accounting and Finance System (B3500), 1 December 1979

[21] TO-00-20-2-2, Technical Manual: On-Equipment Maintenance Documentation for Aircraft; Air-Launched Missiles; Ground-Launched Missiles; Except ICBMS; Drones; and Related Training Equipment, 1 August 1976, updated to 15 October 1982

[22] TO-00-20-2-10, Technical Manual: Off-Equipment Maintenance Documentation for Shopwork, Conventional Munitions, and Precision Measuring Equipment, 1 January 1978, updated to 1 August 1982

[23] AF Manual 66-267, Maintenance Data Collection System (MDC), DSDC: G001BD, Users Manual, 1 October 1979, updated to 1 January 1983

[24] Letter from Chief, Material Systems Division, Directorate of Comptroller Systems, Air Force Data Systems Design Center, to HQ AFLC/MM(VAMOSC), dated 15 September 1983, Subject: "D002A, Daily Consumable Material Cost Data Interface with D160B, Component Support Cost System (CSCS) (your ltr, 15 Aug 83)."

[25] AF Manual 67-1, USAF Supply Manual, Vol. II, Part I, Base Procedures, updated to 18 April 1983

[26] AFLC Regulation 72-2, Cataloging and Standardization, 3 March 1980, updated to 29 May 1982

[27] "Validation of the Algorithm for Base TCTO Overhead Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-02, 15 August 1983

[28] "Validation of the Algorithm for Base Labor Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-06, 13 December 1983

REFERENCES

[1] AF Regulation 400-31, Volume IV (6 August 1982), Visibility and Management of Operating and Support Cost Program (VAMOSC) Component Support Cost System (CSCS)

[2] FD-K-14010C, Functional Description (for the Component Support Cost System (CSCS), Data System Designator D160B, undated draft)

[3] SS-K-15010B, Component Support Cost System/Subsystem Specification, 1 June 1983

[4] TO-00-20-2, Technical Manual: The Maintenance Data Collection System, 1 November 1981

[5] TO-00-20-2-45-2, Operational Supplement to Technical Order: Maintenance Documentation for In-Shop Engine Maintenance, 1 October 1982

[6] Memoranda of Agreement (listed separately)

[7] Letter from Chief, Material, Cost & International Accounting Systems Division, Directorate of Plans & System, HQ USAF, dated 27 Feb 1981, Subject: Direct Labor Rates

[8] Air Force Magazine, May 1983 (Almanac Issue)

[9] AFLC Pamphlet 173-10, AFLC Cost and Planning Factors, 31 December 1981

[10] "A Statistical Evaluation of the Accuracy of Maintenance Direct Labor Data Used in Support of Operating and Support Costs." Desmatics, Inc. Final Report No. 111-1, by Dennis E. Smith, Robert L. Gardner, and Terry L. King, April 1979

[11] "The Air Force Can Improve Its Maintenance Information System," U.S. General Accounting Office Report No. GAO/GGD-83-20, 25 January 1983

[12] Compendium of Authenticated Systems and Logistics Terms, Definitions and Acronyms, School of Systems and Logistics, Air Force Institute of Technology, 1 April 1981

[13] AF Regulation 177-101, General Accounting and Finance Systems at Base Level, 17 March 1980 updated to 1 June 1982

[14] AF Manual 177-380, USAF Standard Base Level Maintenance Cost System (B3500), 19 October 1976 updated to 31 July 1981

[15] AF Regulation 173-13, USAF Cost and Planning Factors, 1 February 1982

4.0a. Office of VAMOSC Comments

Concur.

(2) The methodology for the development of Direct Labor Rates for each MDS that is applied to Base direct labor hours (to develop direct labor costs) has yet to be affirmed.

(3) Adjustment of the Direct Labor Rates for each MDS on the basis of annual inflation factors becomes increasingly inaccurate as time elapses.

Items (1) and (3) have been addressed by reference [17]. Item (2) is still under study, and recommendations will be made in subsequent reports. Items (2) and (3) directly affect a unique element in this algorithm. That element is the worldwide single direct labor rate that is developed for this algorithm. It is applied to the sum of base direct labor hours for all aircraft related SRDs. This worldwide direct labor rate for all MDSs is developed by averaging the escalated FY 80 values for each MDS. A final assessment of the accuracy and appropriateness of this value is therefore dependent upon the resolution of item (2) and will be addressed in subsequent reports.

A recommendation is being considered to improve the procedure for developing the Base Overhead Cost Rate by multiplying the DLR for each MDS times the direct labor hours that can be identified to that MDS. The worldwide single DLR would be applied only to all those base direct labor hours that cannot be identified to an MDS, such as labor hours for GSE. These costs would be added to produce a more accurate Base Direct Labor Cost. This recommendation will not be made until item (2) above is resolved.

4.0 RECOMMENDATIONS

Section 3 has presented an assessment that the algorithm for base TCTO overhead cost is fundamentally sound. Of particular importance in the assessment of this algorithm is the analysis of the manner in which the base overhead cost rate is computed. This importance stems from the fact that the overhead cost rate developed for each base as part of this algorithm is applied to all of the categories of direct labor (on equipment, off equipment, TCTO, etc.) performed by the respective bases. The overhead cost associated with that direct labor is produced in this way. Accordingly the base overhead cost rate impacts several other algorithms that will be the subject of future analysis.

The manner of calculating the base overhead cost rate for each base as described in Section 3 is affirmed. This method of calculation represents the way the CSCS programs actually perform the calculation. The methodology described in both the users Manual and the Functional Description is incorrect. Attachments 1 and 2 provide suggested corrections to these documents.

Even while affirming the basic methodology for computing the base overhead cost rate there are some reservations that must be expressed for some of the actual data source values that enter into the computation. These reservations have been expressed in Reference [17], the ISI report for the Base TCTO Labor Cost Algorithm. They are as follows:

(1) The accuracy of direct labor hours from D056 has been questioned.

TABLE 5

CONTRIBUTION OF BASE TCTO OVERHEAD
COST ALGORITHM ON CSCS OUTPUT REPORTS

OUTPUT REPORT/NUMBER[1]	COST ELEMENTS CONTRIBUTED TO BY THE ALGORITHM[2]
1. MDS Logistics Support Costs/8104	1. By MDS for all bases: a. TCTO costs, base overhead b. Total MDS costs
2. Cost Factors/8105	2. By MDS and base: Base maintenance overhead cost rate by base
3. Base Work Unit Code (WUC) Costs/8106	3. By MDS and base: a. Total Base Costs, TCTO[3] b. WUC on-equipment ov/head[3] c. WUC off-equipment ov/head[3]
4. Total Base Work Unit Code (WUC) Costs/8107	4. By MDS for all bases: a. Total base costs, TCTO b. WUC on-equipment ov/head[3] c. WUC off-equipment ov/head[3]
5. Total Base and Depot Work Unit Code (WUC) Costs/8108	5. By MDS for all bases and depots: Total costs, TCTO

(1)CSCS output reports are assigned Report Control Symbol HAF-LEY (AR) nnnn, where nnnn is the number in the table.

(2)Capital letters indicate the titles printed on the report.

(3)The algorithm provides the base Maintenance Overhead Cost Rates used to develop these costs.

each MDS is understood. This determination is in process and will be reported in subsequent algorithm evaluations.

ISI finds the computation process of the algorithm as described in Section 3.1.1 to be fundamentally sound and affirms the algorithm as both accurate and appropriate. The description of the computation process in both the CSCS User Manual and Functional Description is flawed, and these documents require correction.

3.2.5 Directness of Costing

It is the essence of overhead costs that they are not directly associated with categories of maintenance. In every classic case of determination of overhead costs, the fair share of these indirect costs are allocated to a given value of interest. In this case the value of interest is direct labor hours at the component level. The algorithm performs this calculation in as direct a manner as possible and a more direct costing methodology is neither possible nor necessary.

3.2.6 Application to CSCS Output Reports

Base TCTO labor costs and the elements which are included in the algorithm are components of five CSCS reports, as described by Table 5. The total accuracy of each report cannot be addressed until all algorithms impacting the report and its respective cost elements have been reviewed. This will occur in the final report of this effort. Evaluation of the usefulness of the report will also be provided in the final report of this effort and after ISI conducts a survey of users.

cost rate by the TCTO manhours for MDS 1.

Figure 1 shows allocation for two aircraft, labeled MDS 1 and MDS 2. In fact, the algorithm converts overhead costs to an overhead rate by dividing by direct labor hours, not just for aircraft, but for all SRDs related to aircraft that are reported at a base. Thus the basis for the overhead rate may include direct labor hours for air launched missiles, AGE, trainer, etc. At present, the CSCS does not report costs for equipment other than aircraft.

The primary features of the algorithm are the identification of overhead costs as the difference between total maintenance organization costs and direct labor costs, and the allocation of these costs to categories of maintenance in proportion to direct labor hours.

There is a minor improvement that may be made to the Base Overhead Cost algorithm. A direct labor rate for each MDS is available. These direct labor rates can be applied to all base direct labor costs hours that can be identified to an MDS. Those direct labor hours that cannot be identified to an MDS (such as trainers, AGE, etc.) can be multiplied by the Air Force world wide direct labor rate currently used in the algorithm. The sum of these two products would provide a more refined value for the cost of base direct labor that is subtracted from the cost of operating the Chief of Maintenance organization to produce the base overhead cost. This procedure cannot be properly evaluated until the methodology used to produce the direct labor rate for

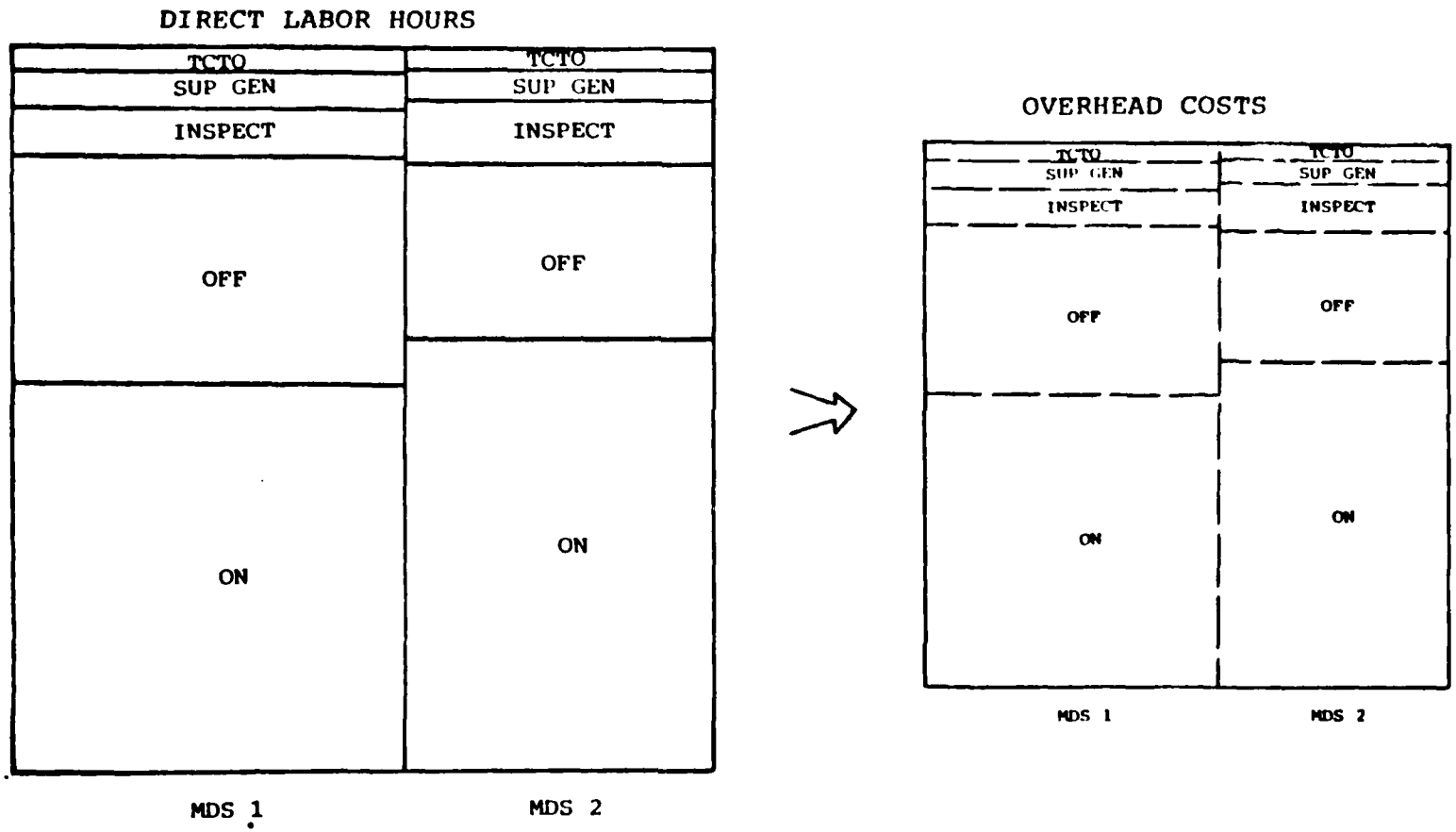

Figure 1. Proportional Allocation of Base Labor Overhead Costs

in developing this cost. This produces a base overhead cost rate that can be applied to any of the direct labor hours generated by aircraft related SRDs at that base. The direct labor hours for each base in this process are multiplied by a direct labor rate that is a single value for all aircraft and is applicable to all bases. This worldwide average Air Force direct labor rate is the average of the worldwide values for each MDS. This average Air Force direct labor rate is used because it is applied to direct labor hours at the base that are a sum of MDS direct labor hours and other direct labor hours (such as for AGE) that cannot be related to an MDS. The process is described in the following computations.

(1) Base Chief of Maintenance Cost - DLR x (Sum of Base Direct Labor Hours)* equals Base Maintenance Overhead Cost

(2) Base Maintenance Overhead Cost Sum of Base Direct Labor Hours* equals Base Overhead Cost Rate/Direct Labor Hour

(3) Base TCTO Manhours/MDS on, off and engine x Base Overhead Cost Rate equals Base TCTO Overhead Cost.

*Includes all direct labor hours (plus Support General) reported by the base for SRDs beginning with A, G, H, N, R, S, T and X. These SRDs define that subset of SRDs that are connected with aircraft operations and maintenance and not just aircraft and engine SRDs.

Data System	Data Element
(1) H069R	RCXX2X (Dollars Amount)
(2) D056A	Base MH, on-equipment, All aircraft-related SRDs

(3)	D056C	Base MH, off-equipment, All aircraft-related SRDs
(4)	D056A	Base MH Support General, All aircraft related SRDs

Attachment 2: Proposed change to CSCS Functional Description (FDK-14010C), paragraph 3.2.3. d., Base Maintenance Overhead Cost

d. Base Maintenance Overhead Cost/MDS:

(1) On and Off equipment man-hours are obtained from D056. The overhead cost rate varies by base and is a function of several variables such as total maintenance man-hours reported at a base and maintenance costs for the Chief of Maintenance organization from the accounting system for operations. Following is a description of how the overhead cost rate will be computed:

$$\text{OH Cost Rate/Base/MH} = \frac{\text{Chief of Maint Total Cost/Base (1)}}{\text{Total Maint MH/SRD/Base (2)}}$$

$$- \frac{\text{(Total Maint MH/SRD/Base (2) x DLR (3))}}{\text{Total Maint MH/SRD Base (2)}}$$

NOTES:

(1) Based on costs reported in HO69R against Responsibility Center/Cost Center (RC/CC) XX20XX, XX21XX, XX22XX, XX23XX, XX24XX, XX25XX, XX2RXX, XX2GXX, and XX2EXX for the following Element of Expense Investment Codes (EEICs): 20X, 391, 392, 393, 396, 40X, 501, 511, 52X, 53X, 549, 55X, 569, 619, 63X, 641, and 693. Cost will be summarized for all the above RC/CCs.

(2) Includes all man-hours expended on components, Support General and TCTO work (MDS and non-MDS) reported at a base (will include SRDs beginning with A,G,H,N,R,S,T, and X). Thus, the algorithm for base maintenance overhead cost for an MDS

is as follows: (Total on-equipment MH/WUC/MDS Base + Total off equipment MH/WUC/MDS/Base) (OH Cost Rate/Base/MH).

(3) A constant which is an Air Force wide average for military labor for all MDS.

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This study is the second of a set of reports documenting the findings of a study conducted by Information Spectrum, Inc. (ISI) for the Office of VAMOSC, Air Force Logistics Command. This study constitutes an assessment of the algorithm for the Base TCTO Overhead Cost employed within the Component Support Cost System (CSCS) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Cost System. CSCS deals with subsystems

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20. and components for aircraft.

Base maintenance organizations incur costs other than direct labor. These other costs are generally not associated with any particular MDS, and are identified as base maintenance overhead. The CSCS system calculates overhead cost per direct labor hour, (including Support General) for each base. This overhead rate (per hour) is multiplied times the TCTO (Time Compliance Technical Orders) manhours to produce the cost of base maintenance overhead associated with TCTO labor expended for each MDS. The base overhead cost rate discussed in this report is applicable to the development of base maintenance labor, not just TCTO.

This volume presents ISIs conclusions and recommendations, and the comments of the Office of VAMOSC.

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